

Attachment A

RESCO Technical Integration

Partial List and Discussion of Potential RESCO Technical Integration Projects

Introduction:

This solicitation seeks proposals from communities wishing to develop, pilot or implement plans to transition to primary dependence on local or nearby renewable energy supply in the coming decade. If successful, such communities will achieve a level of energy security that distinguishes them from others that continue to rely exclusively on importing energy from sources far from the community; hence the title of the solicitation, Renewable-based Energy Secure Communities (RESCOs). This attachment addresses only RESCO Technical Integration projects.

This solicitation also seeks to support RD&D efforts on certain collateral categories that may be important to some or all RESCO communities at some stage of their development. Proposing communities may elect to team with organizations having specialized technical expertise in these collateral categories. In this case, separate proposals are required for a community's technical integration project and for the community's collateral project(s). Attachment B addresses RESCO collateral projects.

For technical integration proposals and for each individual collateral project category, it is the Energy Commission's intention to fund the highest scoring proposals, to the extent of available funds.

Technology Advancement Context:

Several strong trends favor near term integration of renewable energy (RE) products and services in the energy infrastructure of California communities. First, many RE products and technologies are mature and cost-competitive based on available incentives in the US and elsewhere and extensive market experience overseas. The global market for RE is in the range of \$200 billion annually, and it is experiencing 30% annual growth, resulting in steady significant cost reductions driven by market experience and economies of high volume deployment as well as multi-billion dollar annual RD&D investments by the commercial RE industry and other investors. Meanwhile, prices of conventional carbon based fuels and the heat, electricity and other useful energy forms created from them are experiencing rapid, even dramatic increases, as well as unprecedented volatility.

In addition, there is a developing market for the environmental attributes of clean energy that adds to the economic return to the owners of clean energy assets. Communities throughout the world are recognizing the trends and also responding to public interest in creating sustainable local economies operating in harmony with local and regional ecologies. Historically, communities in the US, with the exception of rural communities and some municipalities, have not planned and managed their own energy supply. Accordingly, those communities that now wish to begin to do so face new choices and a significant learning curve. The on-going proliferation of new energy supply and end use options and the rapidly evolving technology menu brings with it both economic opportunity and complexity. It is clear that the best economic solutions will combine many technology solutions in an integrated and optimum way, based on their complementary attributes. This means that communities seeking to build their economies on the foundation of stable energy costs and environmental stewardship need to start with a well conceived plan and continually

adjust their plan based on experience, because major costs and economic consequences are at stake in any event.

Well conceived and carefully crafted RD&D projects can assist and inform the necessary planning and help develop the needed experience. However, the aim of RD&D projects need not be the advancement of particular RE supply technologies but rather the development and application of new tools and enabling technologies that will allow communities to capture the benefits of expanded clean energy supply without incurring undue technology risk. **Accordingly, this solicitation is seeking projects that develop, pilot or demonstrate the new methods, tools, practices, programs and enabling technologies needed by communities for accelerated cost beneficial deployment of RE options in a community energy system context. Advancement of specific RE conversion technologies may occur during a technical integration project but is not a primary target of this solicitation.**

Proposing communities are encouraged to focus on accelerating adoption of viable and proven RE conversion technologies, products and other integrated solutions in a way that maximizes economic value and minimizes costs and environmental impacts.

List of Potential Projects:

Proposed community-based RD&D projects must include development of software and/or hardware solutions and tools. Feasibility studies and bench-scale projects will not be funded under this solicitation. Entities or individuals who wish to pursue funding for feasibility studies and bench scale projects should consider applying to the Commission's Energy Innovation Small Grant Program. Information on this program is available through the Energy Commission's website <http://www.energy.ca.gov/contracts/index.html>.

Eligible projects must help achieve accelerated adoption, implementation, and sustainable growth of RE systems in California. In order for RESCOs to be implemented as rapidly as possible in California communities, it is essential to address integration issues in several dimensions and combinations. Applicants must provide in their proposal an economic analysis either levelized costs analysis or benefits/costs analysis (whatever is appropriate) of their proposed RESCO technical integration project in a form that can be validated through the proposed effort.

Projects in any of the three stages as shown below will be eligible for funding considerations:

1. **Exploratory Stage:** Projects offered by community organizations and their teams must consider the full range of RE solutions consistent with locally available RE resources. As noted in the above introduction, the premise of this solicitation is that typically it will be necessary for a community to exploit multiple RE resource/conversion technology combinations to achieve cost-optimum primary reliance on RE. Further, it will likely also be necessary to plan for some or all of the non-supply integration solutions shown in Figure 1 of the Application Manual. Finally, organizations and teams must show evidence of having the commitment and capacity to follow through on exploratory stage results, i.e. exploratory stage results should include selection and definition of appropriate pilot and implementation projects. Exploratory stage projects are eligible for awards up to \$200,000.
2. **Pilot Stage:** Projects must be offered by community organizations committed to specific and detailed RESCO development plans and must involve hardware development and demonstration employing three or more mature and viable RE resource/conversion

technologies (as shown in Figure 1 of the Application Manual) and addressing two or more of the integration solutions categories listed below. Pilot stage projects are eligible for awards up to \$1,000,000.

3. **Implementation Stage:** Projects must be offered by community organizations already implementing specific and detailed RESCO development plans and must involve hardware development and demonstration employing three or more mature and viable RE resource/conversion technology options (as shown in Figure 1 of the Application Manual) and three or more technical integration solution categories described below. In addition, implementation projects should address energy system design, scale-up and operational and grid integration issues. Implementation stage projects are eligible for awards up to \$2,000,000.

Integration solutions in the following categories are eligible for funding as part of RESCO Technical Integration projects:

1. Integrated RE resources mix
2. Integration of RE electricity resources with efficiency measures and demand response
3. Integration of RE resources and energy storage
4. Integrated Inter-sectoral applications (e.g. transportation and electricity)
5. Integration of Biopower resources and combined cooling, heating and power (CCHP)
6. Integration of Local RE resources and imported RE energy
7. Integration of Renewable Energy Heating and Cooling with Energy Efficiency, Demand Response and On-Site Electricity Generation

Integration Solution Categories

The following paragraphs include brief discussions of the above categories of integrated RE solutions. They are intended to explain the importance of these solutions in a RESCO context, not to suggest particular lines of investigation.

1. Integrated RE Resources Mix

A community's RE mix might include centralized electricity generation, on-site electricity generation, and on-site heating and cooling systems. Relying exclusively on centralized electricity generation might be more expensive than a combination of centralized and on-site generation; likewise, the combination might in turn be more expensive than a broader mix that included on-site heating and cooling systems. A mix of RE resource/conversion system types would likely result in lower overall costs than a single type, especially if a high proportion of energy demand is to be served by RE sources. For example, solar and wind electricity supply might produce relatively low cost electricity at certain times but would not meet demand at other times. Biomass and geothermal sources could operate continuously but would have higher costs if operated only part time. RE resource options will vary from community to community. Planning for development of an RE supply portfolio that fits constraints on resource availability and quality is essential.

Achieving a vision of primary dependence on indigenous RE sources requires a model of the community's future energy supply and use and evaluation of alternative supply scenarios.

RE technologies will have significantly greater value when operated in an integrated fashion than if operated independently. RE projects can be linked in a way to make electricity and thermal energy supply systems more affordable to a community that faces high or volatile

electricity prices. One simple and familiar integration example is the integration of two solar conversion technologies for production of both heat and electricity for use in a building.

The following partial list of questions is offered as an indication of the issues inherent in this category of integrated RE solutions:

- What is the optimum mix of RE technologies (up to 100 % usage) that exhibits some or all of the following benefits?
 - ❖ Matches the demand profiles of appropriate communities.
 - ❖ Reduces costs.
 - ❖ Helps defer transmission and distribution expansions or upgrades.
 - ❖ Reduces congestion and reliability problems.
 - ❖ Manages peak loads.
 - ❖ Offers new value-added products and services.
 - ❖ Improves stability.
 - ❖ Provides power quality benefits to the customer or the electricity system.
 - ❖ Helps provide volt-ampere reactive (VAR) support.
 - ❖ Enhances asset use and land use.
 - ❖ Consolidates and streamline permitting.
 - ❖ Has load following or dispatchability capabilities and,
 - ❖ Reduces air emissions and other environmental impacts.
- What mix of RE technologies can maximize the utilization of waste materials for energy production (cooling, heating, power, and transportation fuels)?
- What is the best way to validate the efficacy of a particular mix of RE technologies to assess performance capabilities in full-scale community-based settings?
- What are the technical barriers facing community choice aggregators relying on local and nearby RE sources versus imported RE electricity?
- Are there RE technologies and products that integrate seamlessly into the customer settings and land use planning while contributing environmental, health and safety benefits?
- What strategies are available for improving efficiencies and lowering capital and O&M costs of integrated RE deployment e.g.,:
 - ✓ Increasing thermal conversion efficiencies
 - ✓ Employing lower cost fuels (e.g., biomass waste materials), lowering resource extraction or collection costs (e.g., biomass or, geothermal for district heating), improving maintenance intervals (all), or cascaded use of resources
- Are there new products, capabilities and diversified revenue streams that help with capital cost recovery and therefore help lower electricity generating costs, e.g.
 - ✓ Co-producing value-added byproducts (e.g., biofuels, chemicals or other feedstocks).
 - ✓ Increasing use of thermal energy.
 - ✓ Enhancing the ability to provide ancillary services or peak generating capabilities.
 - ✓ Employing low NOx biomass co-firing to increase thermal power plant ramp up speed, dispatchability, or peaking capacity.

2. Integration of RE Electricity Resources with Efficiency Measures or Demand Response

California communities aiming for energy security can look to the examples of California energy security pioneers leading the way in integrating RE sources with efficiency measures and demand response.

At least one water agency in California generates most of the continuous supply of electricity needed for its operations from anaerobic digestion of waste-water streams, manure from local dairies and food waste from local food processors. Peaking electricity in this case is supplied by solar photovoltaic systems whose output matches the daily load curve. This agency has achieved the LEED platinum rating for one of its buildings, the highest possible rating for energy and material efficiency and green design of new buildings. It has done so by maximizing use of recycled water, and by adding electric and hybrid vehicles to its transportation fleet along with several electric vehicle charging stations. Thus, this agency represents the RESCO paradigm by achieving primary reliance on several integrated RE sources by deploying RE and reducing energy demand through efficiency measures.

At least one California campus community demonstrates how on-site electricity generation and co-generation of electricity and heat can be integrated with demand response. This campus community generates most of the electricity it uses in a central energy plant that also produces and stores chilled water for cooling campus buildings. Through the ability to over-ride thermostat set-points in campus buildings, facility managers have a demand response capability that allows self-generated electricity to be used to maximum economic effect and even to support the local utility grid during grid emergencies.

Experience with RE deployment in buildings and communities outside the US demonstrates that market uptake of RE sources is significantly enhanced when coupled with investments in energy efficiency. Regarding demand response and load management, California communities in all sectors depend on and are sensitive to the reliability and quality of electric power. Demand response to electricity prices and system contingencies may ensure more reliable energy services while cutting costs.

The following partial list of questions is offered as an indication of the issues inherent in this category of integrated RE solutions:

- How can a combination of mature and cutting-edge renewable energy, efficiency and demand response technologies be integrated in order to enhance the efficiency and dependability of a community's energy infrastructure?
- Can such combinations also defray both costs and effort associated with investments in the regional or statewide energy grid, e.g. by deferring or avoiding transmission and distribution or minimal upgrades and by freeing up existing energy delivery capacity, especially during peak demand periods?
- Do certain hybrid systems e.g., RE systems that include multiple RE sources or energy storage, have superior attributes when coupled with energy efficiency measures?
- What opportunities exist for integrating efficiency improvements and renewable energy technologies common to community-based sectors; e.g., food processing facilities (industrial), dairy and other livestock management practices (agriculture) and waste water management (public infrastructure)?

- Which of the following benefits is most likely to be captured by integrated solutions in this category:
 - ❖ Reducing cost of electricity?
 - ❖ Improving power quality maintenance and reliability?
 - ❖ Improving energy efficiency without compromising reliability and productivity?
 - ❖ Reducing risk in adopting energy efficiency technologies?
 - ❖ Increased need for water and wastewater recovery or gray water use and recovery systems in communities?
 - ❖ Reducing environmental impacts?

3. Integrated RE Resources and Energy Storage

RE resources such as wind, solar, and low-impact hydro are variable energy resources that may require additional technologies to manage and store in a community energy system. Managing seasonal, hourly and minute-to-minute variations may pose additional planning and operational challenges on the existing electricity infrastructure as renewable generation penetration levels in different customer sectors continue to increase.

Communities expecting to rely heavily on variable RE resources, i.e. solar and wind, should consider how energy storage can be used to improve reliability and minimize costs as proportions of RE supply increase. Options that can reasonably be considered include thermal energy storage associated with solar heating, cooling and electricity generation systems, electrical energy storage that may be deployed as part of the local electricity grid, and electrical energy storage that may be deployed on-site either in conjunction with on-site solar and wind conversion systems or for reliability purposes. Longer term scenarios might involve the energy storage capacity of electric and hybrid vehicles.

The following partial list of questions is offered as an indication of the issues inherent in this category of integrated RE solutions:

- Can energy storage make intermittent RE such as solar, wind, and even small hydro to more economically viable, storing energy generated during off-peak hours and for use during peak hours, stabilizing the transmission and distribution grid, enabling more efficient use of existing renewable generation assets and reducing operating costs incurred by current and future thermal generation assets?
- Can economic benefits be captured by:
 - ❖ Improving power quality and reliability.
 - ❖ Improving transmission efficiencies, defraying and alleviating congestion by strategically locating storage-enhanced capabilities in the community grid.
 - ❖ Optimizing renewable energy storage management strategies that minimize risk and optimizing the trade-off between electricity production and storage.
 - ❖ Deploying energy storage technologies as appropriate to provide dispatchability or peak generation.
 - ❖ Enhancing economic, environmental and social benefits for communities by facilitating market penetration of RE to the grid.
- How can energy storage be coupled with RE heating or cooling, combined heat and power, ground source heat pumps, and communication and control systems that enable peak shaving or load following capabilities?

4. Integrated Inter-Sectoral Applications (e.g. Electricity and Transportation)

Communities targeting greenhouse gas mitigation as well as energy security through use of local and nearby RE sources may wish to consider how local bio-energy resources can be used to maximum effect. Options include electricity production, electricity and heat co-production, conversion of biomass feedstocks to pipeline quality methane-rich fuel, and conversion of such feedstocks to transportation fuels, including bio-diesel or near-term ethanol.

The following partial list of questions is offered as an indication of the issues inherent in this category of integrated RE solutions:

- Is there a potential opportunity to deploy bio-fuel generating plants with existing or new biomass power plants or any other renewable power plants in communities in a way that reduces production costs for existing and new facilities? For example, co-location may create new sources of revenue for a biomass power facility plant through sales of electricity and steam to a biofuel facility and may reduce fuel costs through sharing the feedstocks. More specifically, an ethanol facility could use part or all of a biomass power plant's fuel, separate the sugars for ethanol and other by-product production, and return fuel in the form of lignin to help fuel the biomass power plant, thus reducing its total raw material wood fuel needs.
- Is there an opportunity to make an existing biomass power plant more economically competitive by:
 - ❖ Defining the technical interfaces between the new and near-term ethanol facility and the biomass power plant or any renewable plant? These include the technical specifications for steam, electricity, lignin and sharing biomass feedstock.
 - ❖ Define the range of feedstock or other product mixes that minimize the biomass power plant's electrical generation costs?
 - ❖ Define the range of steam and power mixes that optimize the power plant's profitability.
 - ❖ Determine the optimum economic cogeneration configurations between the biofuel facility and the biomass power plant?
- Is there an economic opportunity to coproduce transportation biofuels from renewable waste fats, oil and grease, waste residues or energy crops?
- Is there an opportunity at an existing biopower facility to use low carbon-emitting technology that result in lower life cycle greenhouse gas emissions than conventional fuels?

5. Integration of Biopower Resources and combined cooling, heating and power (CCHP)

Communities exploring, piloting and implementing technologies for conversion of local and nearby biomass resources to electricity will stretch the climate and energy benefits of biomass conversion through co-production of electricity, heat and chilled water, as described above in the example of one campus community with a central energy plant that converts natural gas to co-produce electricity, steam and chilled water for cooling.

The following partial list of questions is offered as an indication of the issues inherent in this category of integrated RE solutions:

- What opportunities exist within the community to use waste fuels, landfill flare gases and other biomass resources?
- Can CCHP solutions make a use of such resources economically viable that would not be viable otherwise?
- Can CCHP solutions be applied to make advanced biomass energy conversion technologies (e.g., integrated biomass gasification, biogas from anaerobic digestion of livestock manure, food processing waste, waste water for direct power production and for pipeline quality gas) more economically and environmentally attractive?

6. Integration of Local RE resources and Imported RE energy

In addition to exploiting local and nearby RE sources California communities have the option to make arrangements to purchase RE electricity from RE power plants connected to the California grid. The Energy Commission has funded feasibility studies related to this option. At this time the option is only available to Community Choice Aggregators formed under regulations implementing AB 117. Additional information on the option is available from a variety of sources including draft reports available from the Energy Commission on request.

The following partial list of question is offered as an indication of the issues inherent in this category of integrated RE solutions:

- What are the technical barriers facing community choice aggregators (CCA) relying on local and nearby RE sources versus imported RE electricity?
- What is the cost-competitive and optimum mix of locally generated energy and imported energy for a specific community?

7. Integration of Renewable Energy Heating and Cooling with Energy Efficiency, Demand Response and On-Site Electricity Generation

Heating and cooling demands by the industrial, commercial, and residential sectors account for 40-50% of total global energy use, and thermal energy uses account for 27% of California's greenhouse gas emissions. Accordingly, renewable energy heating and cooling (REHC) has been described as the "sleeping giant" of renewable energy. Around the world, mature, cost-effective REHC technologies using solar, biomass, and geothermal resources are being used to reduce both carbon dioxide emissions and fossil fuel dependency. For example:

- China accounts for 75% of annual global solar water heating capacity additions. Even Germany, which has poor solar radiation relative to California, has 750,000 solar water heating systems.
- Increasingly, countries and state/local jurisdictions are mandating solar water heating for all new residential and commercial buildings. Spain and Hawaii are two examples.
- Globally, there are more than 2 million units of ground source heat pumps in use, mostly in Europe and other parts of North America; about 30% of houses in Sweden have geothermal heat pumps.

- Globally, heat from modern bio-energy systems is nearly 10 times the combined solar and geothermal total.
- The solar share of Germany's residential space heating market is approaching 50%.

Several mature solar thermal, biomass and geothermal heating technologies entered the mass market many years ago because they were cost competitive with electricity, oil and gas. REHC includes commercially ready technologies, emerging technologies, and industries that offer both.

The following partial list of questions is offered as an indication of the issues inherent in this category of integrated RE solutions:

- How can REHC solutions best be integrated with efficiency measures and building integrated solar electricity solutions to create net zero residential and commercial buildings?
- What capacity exists within the community to deploy REHC solutions along with efficiency solutions, demand response solutions and on-site electricity supply?
- How would REHC deployment serve to accelerate progress toward a community RESCO goal?